The Guard Unit Armory Device Full Crew Interactive Simulation Trainer (GUARDFIST-1)

by First Lieutenant Stephen J. Snyder

"Soldiers can only be ready when they are trained for the job they are doing and doing the job they are trained for. To ensure that our Army can perform as the nation deserves and expects, we must continually ensure that they are assigned where their training, knowledge, and experience contribute to the Army's readiness."

- General Creighton W. Abrams - 1973

The tank commander called for the driver to move out, as the gunner moved his head to view through his auxiliary sight. As the view through the auxiliary sight cleared, the gunner called out "driver stop!" The driver eased on the brake and the tank commander evaluated the range through his primary sight extension and waited for the target to emerge from the treeline it was traveling behind. Once the target cleared this obstacle, he issued the command, "fire!" The gunner announced "on the way!" and squeezed the trigger on his cadillacs. Although no recoil was felt, one was heard through the subwoofer mounted beneath the breech. Shell obscuration shielded attempts by the crew to sense impact of the round. The loader safed the main gun and punched the box mounted on the ready door, waiting for the light to indicate a round was available for loading. Once lit, he pushed the load light on the breech-mounted box and armed the main gun. Once the obscuration cleared, identification of the target showed flames leaping from the side of the turret. A catastrophic hit! The tank commander called "target, cease fire — driver back up" to complete the conduct of fire. Having succeeded in destroying the enemy in another engagement, all of the crew took off their CVCs, dismounted their tank, and made their way across the armory

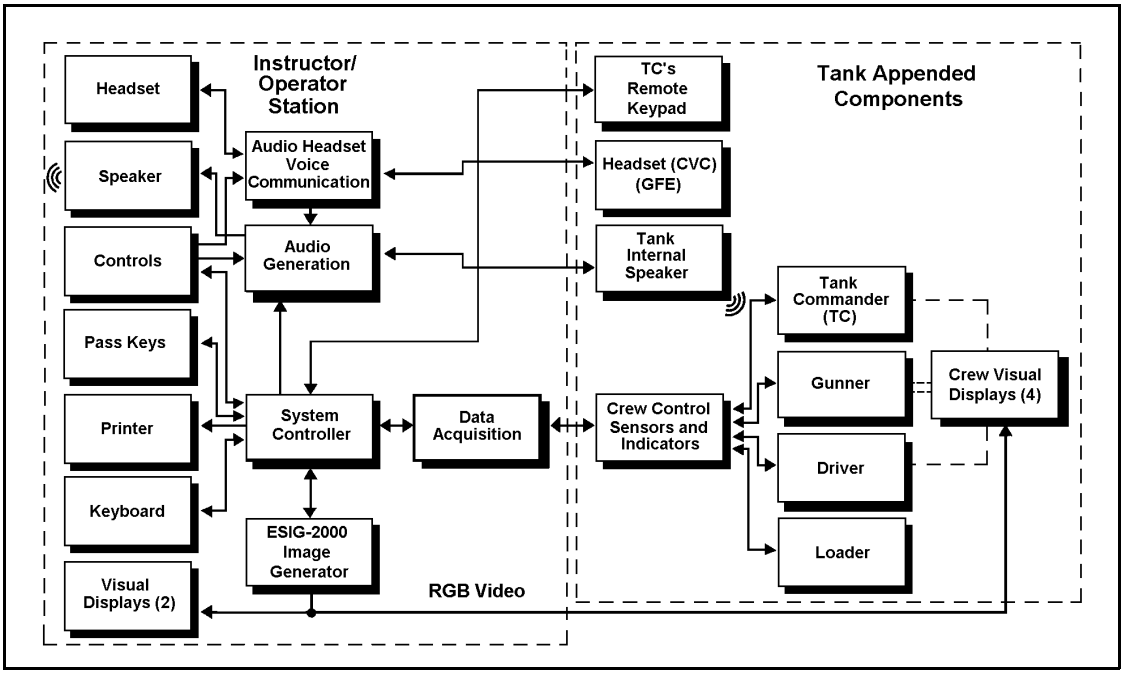


Figure 1. GUARDFIST-1 Systems Architecture

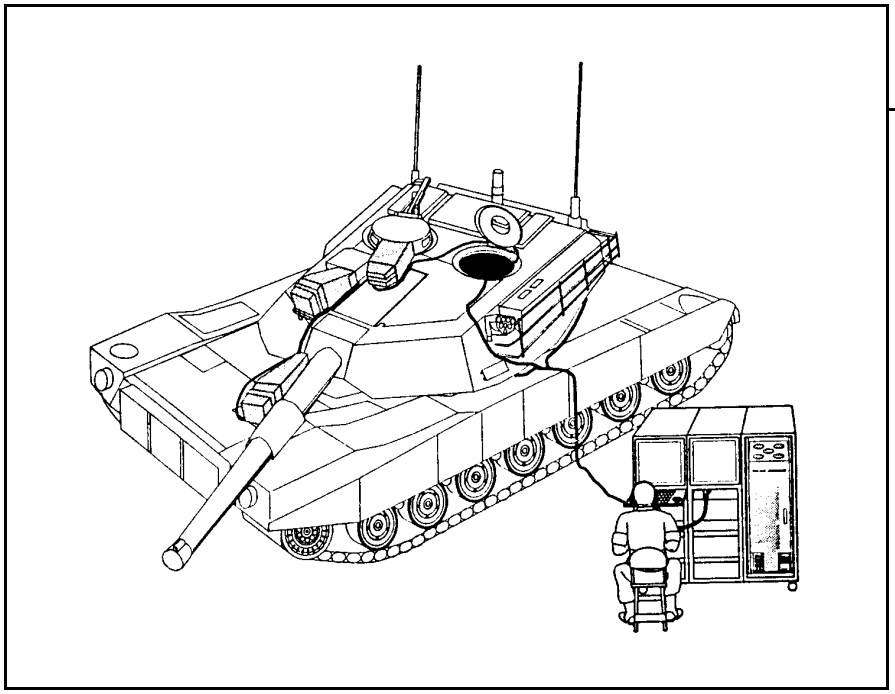


Figure 2. Perspective of M1 Tank with GUARDFIST-1 Appended Training System

hall to the soda machine. The tank commander made a detour to the side of the vehicle to get a hard copy from the printer at the instructor/operator station on the times to fire and reticle aim of his gunner. As he too headed to the soda machine, he looked back at the looming hulk of the M1 sitting in the corner of the armory and he pondered on how much tanking had changed since he first rode on "A5s" and "steel dinosaurs."

The sleepy post of Camp Shelby, Mississippi was the field test site for the lastest in virtual-reality, synthetic environment-based simulators. Camp Shelby's humidity and oppressive heat are known more for wearing out field troops and harboring bird-sized mosquitoes than for assessing simulators. The post housed technicians, instructor/operators (I/O), and Alabama National Guardsmen in conducting field-tests on the simulator, now in the hands of some Guard units. The U.S. Army's latest application of Armor-oriented virtual-reality-based simulators, the GUARDFIST-1[1] was field-tested under the Initial Operational Test and Evaluation (IOTE) program. The purpose of this IOTE was to (1) assess the training effectiveness of GUARDFIST-1 and (2) assess the possible configuration and funding requirements. The program consisted of assessing pre- and post-test scores on modified Tank Tables VII and TTVIII for control and experimental groups. These groups were comprised of four National Guard tank companies, scheduled during their two-week Annual Training period.[2] Optimally, the test would have been conducted during the course of one year, however, a less than ideal test was designed to simulate approximately one year's use,[3] and to obviate delays that have hampered the program, such as software and hardware bugs.

The benchmark targets for assessing the maintainability and integrity of the GUARDFIST-1 system for the IOTE were (1) that the system demonstrated a mean-time-between-operational-mission-failures (MTBOMF) equal to or greater than 170 hours and (2) that the system must demonstrate a mean-time-to-repair (MTTR) less than 30 minutes 95 percent of the time.

On dimensions of both maintainability and experimental/control groups differences benchmark targets were achieved. The GUARDFIST-1 was superior. This is especially important since, unlike the Mobile Conduct of Fire Trainer (MCOFT), the GUARDFIST-1 has many components that must be crated and mounted, increasing the chances for system malfunctions. The system also performed well under adverse environmental conditions. On several occasions, the huts where the tanks and simulators were located becme balmy from humidity. The various GUARDFIST-1 systems performed to standard under such conditions. Heat and humidity are more damaging to such systems, due to cooling requirements of the CPUs and monitors. Upgrading of CPUs to Pentium-class chips will increase the cooling requirements.

"The GUARDFIST-1 program was initiated by a Training Device Requirements (TDR) in 1987, ...and was designed to fill a gunnery training deficiency withing NG armor and cavalry units. Many of these units store the majority of their tanks at installations far from their local armories and do not have access to local training areas and ranges. In order to conduct gunnery training, they must travel, in some cases, hundreds of miles to use their equipment and have access to training areas. This is costly in terms of both training time lost while traveling and assets required to actually move unit personnel. The GUARDFIST-1 is designed to allow NG armor units to more efficiently train their soldiers in tank crew gunnery skills at their local armories."[5] It was also designed so that each armory could house one GUARDFIST-1, mounted on a stationary M1 tank. Current use of MCOFTs for this purpose are allocated on the basis of one MCOFT per battalion. GUARDFIST-1 would quadruple the use of virtual-reality-based simulator training for NG Armor units.

The GUARDFIST-1 is a full-crew, on-tank trainer, with hookups slaved to each crew station's controls. Television monitors are attached to the driver's, gunner's, and TC's optics.[6] All cables and optics are further slaved to a 486-66 microcomputer and driven by a Paradox-engine UNIX-based 32-bit operating system.[7] System components consist of a systems controller, image generation system, audio system, data acquisition system, system software,[8] and the I/O station.

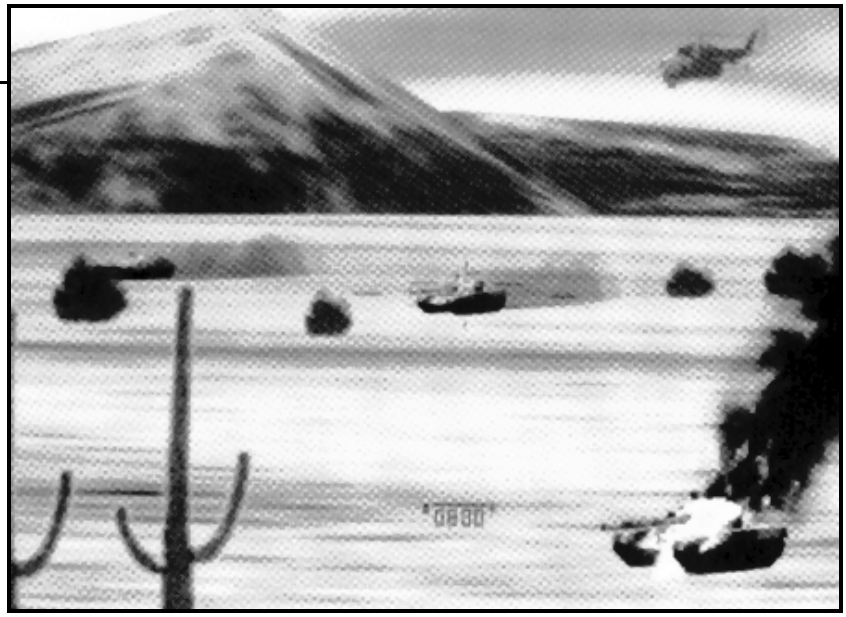
The system controller is the core of the trainer, and synchronizes all activities by communicating with the driver, gunner, and tank commander image generation system. During training on the simulator, the controller reads from exercise scripts, controls the simulation, and monitors the performance of the tank crew. In addition, the controller follows, analyzes, and grades each exercise, and provides printed reports. The image generation system provides the synthetic environment to the TC, gunner and driver's stations. These images are generated from a polygonal database in real time.

The gunner has both the Gunner's Auxiliary Sight (GAS) and the Gunner's Primary Sight (GPS) to view from, including thermal, while the TC has access to the unity periscope and Gunner's Primary Sight Extension (GPSE) as sights. The driver observes through his center vision block from the closed-hatch position. The audio system provides all sound effects, played from digitized sound files, and broadcast through JBL speakers and subwoofers. Audio cues are provided to the crew through the CVC helmets. The data acquisition system consists of mechanical linkages and electrical buffers needed to allow communication between the tank controls and the training device. The I/O station consists of a keyboard to allow control of training programs, two monitors for displaying visual simulation and status information, the console which houses the computer system,[9] and a printer to provide feedback information.

The use of microcomputers instead of minicomputers or mainframes has significantly reduced the cost of GUARDFIST in comparison to its virtual cousin, the COFT. The capabilities of the GUARDFIST-1 include:

- Full crew on-tank training.
- Simulated European and desert terrain.
- Simulated unrestricted tank movement.
- Simulated 360-degree turret rotation.
- Simulated full main gun and coax ballistics.
- Simulated day and night engagements.
- Simulated malfunctions.
- Real tank and gunnery sounds.
- Detailed crew performance printouts.

GUARDFIST-1 is a tank-appended training device that will be used by active, reserve, and NG units for collective tank crew training in a simulated closed-hatch mode on an M1-series tank. Aural cues are provided, representing responses to driver input (engine speed, steering actions, and transmission shifting) and gunner input (weapons firing). During training, the tank is in a dead turret, power-off mode. Visual simulation allows the vehicle to move at will through an exercise or battle environment, constrained only by the physical conditions of the surrounding terrain (trees, rocks, buildings, and water).



GUARDFIST-1 Synthetic-Environment Graphics

Training Environment

Training on the GUARDFIST-1 is quite different from training at SIMNET or on COFTs. Like its virtual reality counterparts, GUARDFIST-1 is hampered by the use of electronics rather than the more solid-feeling hydraulics. Gunnery in the GUARDFIST-1 is also quite different. GUARDFIST-1 simulates firing individual engagements or tank tables, and provides critiques after each engagement. These critiques include exposure time, target identification time, time to fire, and reticle aim, as well as fire command errors or manipulation errors. However, unlike the COFT, where a series of ten engagements are run before stopping to critique, the GUARDFIST-1 gives grades after each engagement. During the field test, this proved distracting to many crews who were used to firing a series of engagements before being critiqued. Evaluation after each engagement tended to break the rhythm that the crew was developing. On the plus side, GUARDFIST-1 has an innovation in the TC's compartment. A magnetic box mounts above the TC console, and permits running of the simulator from the TC station. This box has toggles that switch the TC's unity periscope view back and forth between the synthetic environment view and the view that is presented to the instructor/operator. This capability allows the I/O to better show the TC results of engagements and prepare the TC for subsequent engagements. Should an I/O not be available, a qualified TC can operate the trainer from his station.

At the loader's station, boxes attach to the ready door and the breech to simulate duties that the loader must perform. Unfortunately, the loading time was taken from standards from the 17-12-1-1 for an M1A1 — 7 seconds per load. TC's and gunners found this an annoying delay, and loader's continually complained that loading time should be variable, depending on the speed of each individual loader. The loader must also move the safety arm to the safe position before reloading each round. Other than loading, the loader has little to do. He is not provided with a monitor and cannot assist in scanning.

The driver in the GUARDFIST-1 must conduct his normal duties, including moving out to a hull down position when conducting defensive engagements. Should the driver move out too little or too much, either a berm shot results or the gun tube ends up pointing at the ground. The only difficulties experienced at the driver's station were an occasional loss in calibration on the T-handle, which required a few minutes for the I/O to recalibrate, and no sense of feeling for where the driver was going. This was particularly true when moving up during defensive engagements.

The quality of the synthetic environment in the GUARDFIST-1 is a significant improvement over the graphics of both SIMNET and COFT, including the newer COFT graphics disk. Tanks are no longer box-shaped, but have lines similar to actual BMPs and T-72s. Rounds have two different effects

when hits are scored on targets. The first occurs during a mobility kill. The target will no longer move, but can still fire. The second type of target strike is a catastrophic hit. When such a hit is made, the tank flames to signify the ammunition cooking-off. In addition, the vehicle remains on the battlefield, adding smoke and flame to the battlefield obscuration. Hits are also possible through tree branches and small berms. Every detail of the synthetic environment is realistic, including toolsheds, bars, and horizons. Target acquisition under desert conditions tested the best of eyes, and made crews adept at looking for muzzle flashes to identify locations of targets.

The quality of instruction on the GUARDFIST-1, like most other training, is only as good as the training devices and the trainers. GUARDFIST-1 instructor/operators were highly qulaified to perform their duties. They were enthused about the capabilities of GUARDFIST-1 and up to all assigned duties, including correcting system malfunctions during training. Since the same two I/Os worked with each crew during their entire week of training week of simulator training, a rapport was developed, and both the crew and the I/O learned each other's training habits.

The rigor of training of GUARDFIST-1 was challenging. Each level of training in the matrix has both training and evaluation modes. Table VIII in the simulator is known affectionately as the "widow-maker," due to its level of difficulty. Targets pass behind treelines, buildings, and outcroppings during engagements, adding to engagement difficulty. While most crews in the experimental groups had a chance to fire TT VIII, few were able to qualify, this after almost 20 hours of simulator training. TT IV, a preparatory Tank Table for TT VIII, took some crews 10 iterations to pass. Crews were well accustomed to donning protective masks by the time they began live fire exercises on TTs IV, VII, and VIII. Upwards of 20 percent of the GUARDFIST-1 training was spent wearing protective masks.

Target acquisition for the TC was daunting. Targets wre indistinguishable through the unity periscope, therefore making the job of target identification a GPS and GPSE task. Good crews soon found that assistance rendered by the driver was critical to good opening times. The driver's view was superior to the tank commander's unity periscope view. This fact made TCs less likely to use the unity periscope to scan and more likely to improve driver/crew interactions. In GUARDFIST-1, the driver takes the place of the eyes of the loader during scanning, since the loader has no optics or viewscreen.

The only other software glitch in GUARDFIST-1 occurred at the TC's station. TC override calibration was sometimes lost, causing the view to appear as though the turret slue drastically when the TC attempted to hand-off control to the gunner. A recalibration quickly corrected such problems.

Use of GUARDFIST-1

At present, the GUARDFIST-1 is not designed to replace the COFT or SIMNET. The capability is being developed to link GUARDFIST-1s together to simulate platoon gunnery, along the lines of the UCOFT's Platoon Gunnery Trainer (PGT). Its primary role in the immediate future will be to supplement NG training at armories. Precision gunnery for tank tables is the strong suit for the simulator. It is not as yet designed to replace the tactics training of SIMNET, or the introductory and matrix training of the COFT. Since GUARDFIST-1 does not at present possess introductory gunner or TC manipulation exercises, its setup is for crewmembers who already have a firm grasp of station duties.

The GUARDFIST-1 system was granted a low rate initial production (LRIP) of 50 units by the Simulation Training and Instrumentation Command (STRICOM), with a first unit equipped date scheduled for April 1995.

Notes

[1]The current name, GUARDFIST, is being changed to A-FIST (Abrams-FIST) as the program target spreads to include a Regular Army dimension.

[2]Details of this report were gleaned from the author's experiences during this experimental training.

[3]An ideal test would have been to put the GUARDFIST-1 through its paces for a full one-year field-testing.

[4]The control group did NOT undergo COFT training. By standard training, I am referring to Conduct of Fire classes, AACs, TCPC, TT IV subcaliber, and TT VII. Results of the experiment could also be due to intercrew differences in skills. The experiment attempted to go around this fact by drawing on a sample size of 28 experimental and 28 control group crews. Crews were forced to maintain integrity, meaning that once the training began, no crewmember could change positions or withdraw from the training.

[5]Taken from page 1-2 of 1994-OT-136OA.

[6]The system at present does not include a monitor for the CWS. Future add-ons will provide this dimension in gunnery.

[7]There were delays in training between engagements, which consisted in wait times due to the 486-66 CPU architecture. In addition, each GUARDFIST-1 only had 8 megabytes of Random Access Memory (RAM). For such a graphics-intensive use, it is recommmended that a minimum of 32 megabytes of RAM be used (of a 56 nanosecond wait state) and a 100 Pentium CPU be integrated. This would reduce wait states to approximately one-tenth of the current levels.

[8]Software was developed according to DOD-STD-2167. Sixty-seven percent of the software was written in C language and 33 percent in ADA. The software is compiled and executed on a UNIX-based operating system.

[9]The console is approximately the same size as the COFT's computer console and is on wheels for ease of movement.

First Lieutenant Stephen (Doc) Snyder was commissioned in Armor from Arizona State University's Army ROTC, where he received an MBA and Ph.D. in strategy. His undergraduate degree was in history from Shippensburg University, Pennsylvania. He is a graduate of AOBC, and is Air Assault qualified. He is currently scheduled for Phase 2 of AOAC and is assigned as XO, B Company, 1st Battalion, 131st Armor, Alabama Army National Guard. He is an Assistant Professor of Management/Management Information Systems at the University of West Florida.